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ORIGINAL ARTICLE

Ethnic differences in body composition, sociodemographic characteristics and lifestyle in people with type 2 diabetes mellitus living in Italy

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Abstract

This study aimed to compare immigrants and Italian natives with type 2 diabetes mellitus (DM2) in terms of anthropometric parameters and lifestyle-related characteristics and to investigate the relationship between ethnicity and glycemic control in men and women with DM2 living in Italy. The sample included 100 immigrants (55 Albanians and 45 Africans) and 100 Italians, followed by the Public Health Clinics of Rimini. The association of ethnicity with sex, socioeconomic status, anthropometric and hematological characteristics, and lifestyle were examined. In addition, differences among groups in glycemic control were evaluated. Among males, African participants presented significantly lower values than other groups in adiposity parameters and triglycerides. The highest percentage of obesity and of normal weight was found in Italians and in Africans, respectively. Among females, there were scanty differences, but Italians presented higher WHR values than the other groups. No statistical differences appeared in hematological parameters among groups. There were no significant differences in glycemic control among groups and sexes. Also considering the differences between subjects with optimal (L) or nonoptimal (H) glycemic control, the differences in lifestyle, anthropometric, and hematological variables remained scarce. Among all groups, significantly higher values of glucose were detected in H than in L. A similar condition appeared for triglycerides in males. Immigrant and native Italian diabetics did not present any difference in their clinical characteristics, but Italians generally presented worst lifestyle habits. The percentage of subjects with poor metabolic control of diabetes was not low, but similar in immigrants and natives.

Highlights

- There is a clear necessity to acquire knowledge of diabetes in immigrants through better data collection, especially in view of the scarcity of epidemiological studies evaluating the importance of this problem in EU countries.
- The percentage of subjects with poor metabolic control of diabetes is high, and generally comparable between immigrants and natives.

Keywords Body composition · Glycemic control · Immigrants · Italy · Lifestyle

Introduction

The prevalence of diabetes is markedly increasing all over the world and represents a significant public health problem, becoming a priority in the agenda of world decision makers [1] Diabetes is one of the major causes of morbidity and mortality in Europe and is expected to increase in the near future [2]. In Italy, ~5.3% of the total resident population (16.5% among people aged 65 and over) has been diagnosed with type 2 diabetes mellitus (T2DM), hence the spread of diabetes has almost doubled in 30 years, since it affected 2.9% of the population in 1980 [3]. Diabetes is not

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equally distributed among all population groups, as it is associated with socioeconomic disadvantage and lifestyle. Dietary habits, obesity, and sedentariness are important risk factors for health in general, but even more so for people with diabetes [2–4]. These factors, combined with other lifestyle-associated health issues such as tobacco use and alcohol consumption, can also strongly affect the long-term consequences of diabetes [5–7]. In addition, higher rates of diabetes have been observed among women and ethnic minorities [2, 8, 9]. It is recognized that ethnicity has a general influence on the risk of diabetes mellitus (specifically T2DM) [10–14]. Immigrants may be at particular risk due to genetic susceptibility to insulin resistance, higher prevalence of obesity, difficult transitional phases, and rapid changes in diet and lifestyle, as well as linguistic, cultural, and financial barriers to obtaining proper healthcare [15–20]. A higher prevalence of overweight and obesity and a higher frequency of physical inactivity have been observed in immigrants compared with resident population, underlining a greater health risk [20, 21]. The rates of mortality and morbidity linked to nutrition-related noncommunicable diseases are higher in immigrants than in residents and in the population of their home country [22–24]. This is partly due to the fact that immigrants living in Western countries tend to adopt the so-called 'Western lifestyle', characterized by a high prevalence of cigarette smoking, alcohol intake, and physical inactivity, with a consequent increase in overweight [25–27].

The issue of immigration is important in Western societies, which are becoming more ethnically diverse due to accelerated migration from other areas of the world. In Italy the percentage of international migrants as a percentage of the native population increased from 2.5% in 1990 to 7.4% in 2010 [28]. Their presence is higher in northern Italy, with areas providing more jobs opportunities. In Emilia-Romagna, a region of Northeast Italy, the ethnic minority represents an estimated 11.9% of the resident population. The largest foreign community comes from Romania with 16.6% of all foreigners present in the territory, followed by Morocco (11.7%) and Albania (11.0%). In particular, foreigners residing in the province of Rimini represent 10.7% of the population. In this province, the largest foreign community is the one coming from Albania with 19.9% of all foreigners present in the territory, followed by Romania (15.9%), Ukraine (13.2%), People's Republic of China (6.2%), Morocco (5.9), and Senegal (4.5) [29]. The health status of immigrants is therefore a crucial aspect. In diabetic subjects, both immigrants and locals, one of the most important issues is to prevent cardiovascular complications, as there is a well-known correlation between diabetes and cardiovascular diseases [30, 31]. Scientific evidence to guide the prevention and management of cardiovascular disease in patients with diabetes has demonstrated that intensive glycemic control (HbA1c ~7.0% = 53 mmol/mol) has long-term beneficial effects on microvascular complications, cardiovascular disease, and mortality [32–37]. Metabolic control is generally poor among immigrants with diabetes, and HbA1c is usually higher in migrants than in the native-born population, increasing the risk of diabetic complications, even if studies have been contradictory at times [38–43]. In view of the growing evidence that some population groups have a particular predisposition to developing T2DM, an understanding of the lifestyle factors that make some ethnic group more vulnerable could be a starting point for the planning of effective strategies to prevent and manage this disorder. The objectives of this study were to compare immigrants and Italians with T2DM in terms of anthropometric parameters and lifestyle-related characteristics and to assess any inequalities in glycemic control. These data could be helpful in limiting the incidence of future diabetes complications and in avoiding the consequent burden on the healthcare system.

Materials and methods

Participants

The study sample consisted of 200 subjects living in Italy and belonging to the following subsamples: (i) 100 Italian natives (M = 68; F = 32); (ii) 100 immigrants subdivided in African immigrants (M = 33; F = 12) and Albanian immigrants (M = 30; F = 25). A questionnaire regarding sociodemographic and lifestyle information was administered to participants. In addition, anthropometric measurements and an assessment of hematological parameters were performed. The survey was carried out at the Public Health Clinics (Infermi Hospital) of Rimini, Emilia Romagna region (northern Italy).

Ethnic origin was based on the participant's country of birth and was self-reported; immigrants were all first-generation immigrants.

All participants gave written informed consent after a detailed description of the study procedures. All the subjects were interviewed and they filled in a questionnaire providing sociodemographic data (date and place of birth, marital status, level of education, and for immigrants, years since their immigration to Italy and to Emilia-Romagna) and lifestyle data (cigarette smoking, alcohol consumption, sport practice, and intensity of physical activity). The sports activity has been evaluated as practiced or not practiced. The subject had to specify if, among the physical activities practiced, there was at least half an hour of walking per day.

The project was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved

by the Ethics Committee of the Romagna Area Regional Health System.

Anthropometry

The anthropometric survey consisted of the measurements of height, weight, relaxed arm circumference, waist (WC) and hip (HC) circumferences, and triceps skinfold thickness. All anthropometric measurements were taken according to standard methods by the same operator [44]. Height was measured to the nearest 0.1 cm using an anthropometer (GPM, Switzerland). Body weight was measured to the nearest 0.1 kg (light indoor clothing, without shoes) using a calibrated electronic scale. Relaxed arm circumference, WC and HC were measured to the nearest 0.1 cm with a nonstretchable tape as follows: relaxed arm circumference was measured at the midpoint between the acromion and the olecranon, WC at the midpoint between the lowest rib margin and the iliac crest and HC at the widest part of the hip. Triceps skinfold thicknesses were measured to the nearest 0.1 mm using a Lange skinfold caliper at the same measurement level as relaxed arm circumference (Beta Technology Inc., USA).

BMI was calculated as weight (in kilograms) divided by the square of height (in meters). Subjects were classified as normal weight, overweight, and obese based on the World Health Organization (WHO) cutoffs [45]. Since no subject was underweight, they were classified into three categories: normal weight, overweight, and obese.

Waist-hip ratio (WHR) was computed as WC/HC and health risk was valued according to the cutoff proposed by WHO [45]. Triceps skinfold thicknesses were used in anthropometric regression equations to predict body composition parameters (Fat percentage = %F; fat mass = FM and fat free mass = FFM). The total upper arm area (TUA, cm^2), upper arm muscle area (UMA, cm^2), upper arm fat area (UFA, cm^2), and arm fat index (AFI, %) were calculated on the basis of triceps skinfold and relaxed arm circumference [46].

Hematological parameters

Serum total cholesterol and triglyceride concentrations (TAG) were determined by the enzymatic colorimetric assay (Technicon Instruments, Ltd, New York, NY, USA), while HDL cholesterol was determined enzymatically in the supernatant after precipitation of other lipoproteins with dextran sulfate magnesium. LDL cholesterol was calculated using Friedewald formula. Fasting plasma glucose (GLY) was measured using Randox glucose GOD-PAP kits (Randox, Antrim, UK). HbA1c was measured by exchange high-performance liquid chromatography using standardized laboratory procedures.

Statistical analyses

The distribution normality of characters was verified with the Shapiro–Wilk test. The log-transformed values of triceps skinfold, TAG, HDL, LDL, and HbA1c were applied and GLY was transformed as the reciprocal of the value before the statistical analyses were performed [19, 20].

The prevalence rates of qualitative characters and the means and SD of quantitative characters were calculated for all groups by sex and ethnicity.

Due to significant age differences between ethnic groups, one-way ANCOVA, controlling for age, was performed to test differences among groups within each sex. The *t*-test was used to assess differences between the sexes, within each ethnic group, while differences in the frequencies were tested by the chi-square test (with Fisher's exact test and Bonferroni correction pairwise comparison, when appropriate).

Optimal glycemic control of the subjects was considered as an HbA1c < 53 mmol/mol (7%) [47] and further analyses were performed using this value as a cutoff to define the proportion of subjects with optimal (L) or nonoptimal (U) glycemic control in each group. Within each group, the difference between U and L in anthropometric parameters, sociodemographic and lifestyle data were considered using the *t*-test or chi-square test according to the type of statistical variables.

A probability (p) level of <0.05 was considered statistically significant. Statistical analyses were performed using the Package "Statistica" version 8.8 (StatSoft, Tulsa, OK, USA).

Results

The sociodemographic, nutritional, and lifestyle characteristics by ethnic group and sex are reported in Table 1. Age significantly differed among groups: in both sexes, Italians were significantly older than Africans and Albanians, and Africans were the youngest. African males had been living in Italy for 23.8 years on average and Albanians for 15.3 years, the difference being significant ($p < 0.001$). The years of residence in Italy did not differ between female subgroups (14.4 in Africans vs 13.5 in Albanians; $p = 0.75$). A significant sex difference in length of residence in Italy and in Emilia-Romagna was observed in Africans since males had been living in Italy and in Emilia-Romagna for a longer time than females. The evaluation of sociodemographic parameters (Table 1) showed that marital status significantly differed among males: Italians presented a lower percentage of married people and higher proportions of single and common law. Among Italians, there was a significant sex difference in marital status: widowed people were more

Table 1 Sociodemographic, nutritional (prevalence of BMI categories), and lifestyle variables by ethnic group and sex

	Italians		Albanians		Africans		Groups differences (Males)	Groups differences (Females)	Sex differences (Italian)	Sex differences (Albanians)	Sex differences (Africans)
	Males Mean (SD)	Females Mean (SD)	Males Mean (SD)	Females Mean (SD)	Males Mean (SD)	Females Mean (SD)	*P* value[a]	*P* value[a]	*P* value[b]	*P* value[b]	*P* value[b]
Age (years)	61.6 (14.9)	67.5 (13.2)	60.2 (8.3)	54.4 (12.9)	51.5 (7.5)	50.4 (18.1)	0.001	<0.001	0.057	0.052	0.772
Years in Italy	–	–	15.3 (7.7)	13.5 (6.5)	23.8 (8.4)	14.4 (11.1)	<0.001	0.748	–	0.364	0.004
Years in Emilia-Romagna	–	–	14.2 (7.3)	13.2 (6.5)	22.7 (7.9)	14.4 (11.1)	<0.001	0.676	–	0.608	0.008
	%	%	%	%	%	%	*P* value[c]	*P* value[c]	*P* value[c]	*P* value[c]	*P* value[c]
Marital status											
Married	67.6	62.5	93.3	80.0	87.9	58.3	0.018	0.407	0.001	0.015	0.356
Divorced	8.8	3.1	3.3	4.0	3.0	8.3					
Common-law	13.2	3.1	–	8.0	3.0	16.7					
Widowed	2.9	25.0	3.3	8.0	–	16.7					
Single	7.4	–	–	–	–	–					
Religious	–	6.3	–	–	6.1	–					
Educational level											
None	–	–	–	–	21.2	25.0	<0.001	<0.001	0.063	<0.001	0.057
Primary school	22.1	46.9	13.3	8.0	27.3	8.3					
Junior high school	42.6	31.3	46.7	24.0	39.4	25.0					
University	30.9	15.6	40.0	52.0	6.1	33.3					
	4.4	6.3	–	16.0	6.1	8.3					
Weight status											
Normal weight	14.7	15.6	6.7	16.0	42.4	8.3	0.003	0.737	0.179	0.051	0.254
Overweight	35.3	53.1	56.7	36.0	42.4	50.0					
Obese	50.0	31.3	36.7	48.0	15.2	41.7					
Smoker											
No	26.5	59.4	30.0	92.0	69.7	91.7	<0.001	0.032	0.005	0.261	<0.001
Yes	23.5	18.8	16.7	–	15.2	8.3					
Ex	50.0	21.9	53.3	8.0	15.2	–					
Alcohol											
Yes	76.5	34.4	56.7	20.0	6.1	0.0	<0.001	0.049	<0.001	0.006	0.383
Sport											
No	80.9	93.8	93.3	96.0	87.9	91.7	0.400	0.055	0.006	0.912	0.420
High-intensity activities											
No	91.2	–	–	–	78.8	–	0.081	–	–	–	–
Moderate-intensity activities											
No	35.3	50.0	33.3	56.0	39.4	75.0	0.873	0.329	0.161	0.091	0.0035
Walk											
Yes	100	100	–	–	100	100					

[a]Comparisons performed using ANOVA

[b]Comparisons performed using the *t*-test

[c]Comparisons performed using the χ^2 test

frequent in females while divorced and common-law subjects were more frequent in males. A sex difference was also observed in Albanians, with widowed, divorced, and common-law subjects prevailing in females.

The level of education showed significant differences among ethnic groups, being generally lower in Africans than in Italians and Albanians in both sexes. In addition, among females, Albanians had the highest level. Indeed, there was a sex difference in Albanians, with females having a higher level of education than males.

The male sample presented a different distribution of the weight status, since the highest percentage of obesity was observed in Italians and of normal weight in Africans. In contrast, the differences among females and between sexes were not significant.

In males, Africans showed the highest percentage of nonsmokers and the Italians of smokers (Table 1), although in both Italian and Albanian males the ex-smokers prevailed over the other categories. The majority of Albanian and Africans females were nonsmokers, while the Italian females showed higher percentage of smokers. Significant sex differences were observed: in all groups the percentage of smokers was higher in males than in females, especially in Africans and Albanians. As regards alcohol consumption, in males, Africans showed significantly lower frequencies than Albanians and Italians, while in females there was a significantly higher prevalence in Italians than in Africans (Table 1). There were generally no significant differences in sport practice (except for the sex difference in Italians) or in intensity of physical activity (except for the sex difference in moderate-intensity in Africans) (Table 1).

With regard to differences among subgroups within each sex (Table 2), one-way ANCOVA, controlling for age, showed that African males were significantly taller than the subjects of the other two subgroups. Moreover, Africans presented significantly lower values than Italians for WC and HC, and significantly lower values than Italians and Albanians for BMI, WHR, %F, and FM. Triglycerides were also significantly lower in Africans than in the other groups. African females were significantly taller than the women of the other groups, while Italian females presented significantly lower values than Albanians for upper arm circumference and total arm area and significantly higher values than the other groups for WHR. Even if the

Table 2 Comparison of anthropometric and hematological parameters (ANCOVA) among ethnic groups within each sex

	Males								Female							
	Italians		Albanians		Africans				Italians		Albanians		Africans			
	X	SD	X	SD	X	SD	*F*	*P*	X	SD	X	SD	X	SD	F	*P*
Height (cm)	169.1	7.2	168.6	7.6	173	7.4	4.6	0.004	154.3	7	155.7	6.1	158.8	7.5	6.3	0.001
Weight (kg)	89.1	19.3	85.2	14.7	79.4	12.6	2.6	0.057	70.3	13.8	79.0	19.2	75.6	13.0	1.4	0.249
Mid upper arm circumference (cm)	29.7	3.2	29.5	2.8	29.7	3.3	0.0	0.986	28.3	3.8	31.7	4.4	30.8	3.8	3.5	0.021
Waist circumference (cm)	104.3	13.5	100.6	10.0	94.3	11.7	9.3	0.000	94.5	11.8	95.3	15.9	93.8	11.5	2.2	0.094
Hip circumference (cm)	107.2	13.2	102.4	8.9	100.6	7.4	3.7	0.014	105.1	12.1	108.8	14.9	108.6	7.2	0.6	0.645
Triceps skinfold thickness (mm)	9.5	3.9	8.6	2.3	8.9	3.6	0.4	0.766	16.5	6.0	20.7	6.5	18.4	8.4	1.7	0.175
BMI (kg/m^2)	31.2	6.7	29.8	4.3	26.5	3.9	6.4	<0.001	29.5	5.4	32.6	7.8	29.9	4.3	1.9	0.145
Waist to hip ratio	0.97	0.1	0.98	0.1	0.94	0.1	7.3	<0.001	0.90	0.1	0.87	0.1	0.86	0.1	5.1	0.003
Fat mass (%)	24.8	6.0	24.6	3.9	24.0	5.8	4.5	0.005	32.6	5.8	35.1	5.9	32.1	7.9	1.5	0.232
Fat mass (kg)	22.4	7.9	21.2	5.5	19.3	6.2	2.9	0.035	23.3	7.2	28.4	10.8	24.9	9.4	1.8	0.163
Fat free mass (kg)	66.7	13.9	64.0	10.3	60.1	9.0	2.3	0.084	47.0	8.4	50.6	9.4	50.8	7.1	1.2	0.332
Total upper arm area (cm^2)	71.1	15.4	69.7	13.4	71.0	15.3	0.1	0.975	64.9	17.5	81.4	22.9	76.3	18.8	3.4	0.022
Upper arm muscle area (cm^2)	57.5	12.0	57.6	11.2	58.4	12.9	0.0	0.987	43.2	10.8	51.1	12.9	50.1	10.2	2.7	0.055
Upper arm fat area (cm^2)	13.6	6.3	12.1	3.6	12.7	5.4	0.5	0.660	21.7	9.8	30.2	12.2	26.2	13.5	2.6	0.060
Arm fat index (AFI)	18.7	6.6	17.3	4.1	17.6	6.5	0.5	0.666	32.6	8.0	36.2	7.8	33.0	11.1	1.1	0.364
Blood glucose (mg/dl)	150.3	59.6	186.0	101.7	140.1	48.6	1.2	0.298	162.8	58.8	160.2	67.4	162.3	43.5	0.5	0.670
Total cholesterol (mg/dl)	165.8	38.7	163.2	43.5	166.3	35.6	2.2	0.088	182.6	45.2	184.4	41.1	167.1	41.6	0.9	0.433
HDL cholesterol (mg/dl)	45.3	17.7	41.6	11.7	50.8	14.8	3.7	0.013	56.0	16.4	52.5	13.0	50.4	13.5	0.4	0.736
LDL cholesterol (mg/dl)	90.0	36.7	86.5	29.0	94.6	33.9	1.3	0.271	102.3	41.7	99.8	33.0	100.8	43.4	0.1	0.930
Triglyceride (mg/dl)	163.5	90.1	165.4	86.3	106.3	45.8	6.0	0.001	126.8	57.2	138.0	68.4	113.6	53.3	1.2	0.306
HbA1c (mmol/mol)	63.1	17.0	67.1	19.7	62.0	17.9	0.5	0.698	67.1	20.6	62.1	16.2	64.7	13.6	0.9	0.436

differences in hematological parameters were not marked among groups, Italian females presented higher values than recommended for LDL, while Italian and Albanian males had higher values than recommended for triglycerides. In all groups, the value of HbA1c varied from 62.0 to 67.2 mmol/mol (~8.0%) and was higher than recommended.

Differences between sexes within each ethnic group (Table 3) were significant for height (higher in males) and for all parameter related to body composition, indicating higher adiposity in females and greater muscularity in males. There were higher values of fat distribution (WHR) in males, although the values were above the cutoff (WHO, 2008) in all the considered subgroups. As concerns the hematological parameters, significant sex differences were observed in Italians and Albanians for HDL, with females having the higher values.

Table 4 shows the percentage of subjects with optimal/nonoptimal glycemic control and the comparison of their demographic characteristics and weight status. There were no significant differences in glycemic control among groups and the sexes. The percentage varied in males from 65.6% (in Africans) to 75% (in Italians) and in females from 71% (in Italians) to 80% (in Albanians). Even when level of education, weight status, cigarette smoking, alcohol consumption, sport practice, and intensity of physical activity were considered, the differences between U and L remained low within each group and sex. The only differences were detected in Italian males, where U showed a higher prevalence of alcohol consumers than L, and in Africans, where U showed higher frequencies of no moderate-intensity activities than L.

Small differences between H and L were also found for anthropometric and hematological variables (Table 5). Noteworthy was the higher value of WHR in U than in L in Italian males. There were significantly higher values of glucose in U than in L in all groups, except in African females. The same condition appeared for TAG in males.

Discussion

The aims of this study were to compare Italian immigrants and Italian natives with T2DM in terms of differences in anthropometric parameters and lifestyle-related characteristics and to assess any inequalities in glycemic control. The few published data show that the risks of mortality or morbidity due to diabetes are greater in immigrants and depend on ethnic origin [48, 49] Testa et al. [2] reported that obesity and T2DM are highly prevalent among African migrants compared with people of European descent. In the present study, no significant differences in risk factor-related anthropometric characteristics were detected among ethnic groups. Although all the groups presented higher WHR values than the cutoff [45], African males had significantly lower values than Italians for WC and HC, and significantly lower values than Italians and Albanians for BMI, WHR, %F, and FM. Triglycerides were also significantly lower in Africans than in the other groups. Italian and Albanian males had higher values than recommended for TAG. Among females, Italians presented significantly lower values than Albanians for upper arm circumference ($p < 0.05$) and total arm area ($p < 0.05$), and significantly higher values for WHR. In addition, they presented higher values than recommended for LDL. In all the groups the mean values of HbA1c were ~8.0%, being higher than the recommended value. Differences in weight status were only observed in males, but, once again, the highest percentage of obesity was observed in Italians and the highest percentage of normal weight in Africans. Therefore, the present data did not confirm findings of other studies conducted in northern Europe, according to which some immigrant groups in Europe show an increased prevalence of diabetes, e.g., South Asians in the UK and Moroccans and Turks in the Netherlands [2, 50]. In the present study, the differences among groups were small and, when present, showed a higher risk in Italians for adiposity-related parameters and a lower risk in Africans.

There were differences among groups for socio-demographic and lifestyle characteristics, especially in males. The level of education was generally lower in Africans than in Italians and Albanians. In this regard, Vandenheede et al. [51] reported that education and diabetes mortality were inversely related in Europe in the 2000s. Among the considered subgroups, the worst lifestyle habits were observed in Italian natives. It should be noted that this sample of the Italian population was characterized by a low level of education and the main occupations were manual labor or artisanry. In males, Africans showed the highest percentage of nonsmokers and Italians the highest percentage of smokers. Among females, the majority of Albanians and Africans were nonsmokers, while the Italians showed higher percentage of smokers. Both in males and in females the prevalence of alcohol consumption was significantly higher in Italians than in Africans. Significant sex differences were observed, since in all the groups the percentages of smokers and of alcohol consumption were higher in males than in females, especially in Italians and Albanians. No significant differences were observed in the sport practice, which was very low in all groups, and in the intensity of physical activity. In general, the rates of obesity and physical inactivity are reported to be particularly high among diabetic immigrants of non-Western origin, particularly in women [52]. Yet, in the present study the obesity rate was higher in Italians and no differences were found between immigrants and native-born subjects in terms of physical inactivity. It is noteworthy that North Africans and Albanians were among the most representative ethnic groups in the examined area (Emilia-Romagna). In the present study,

Table 3 Comparison of anthropometric and hematological parameters (*t*-test) between sexes within each ethnic group

	Italians						Albanians						Africans					
	Males		Females				Males		Females				Males		Females			
	Mean	SD	Mean	SD	*t*	*P* value	Mean	SD	Mean	SD	*t*	*P* value	Mean	SD	Mean	SD	*t*	*P* value
Height (cm)	169.1	7.2	154.3	7.0	9.7	<0.001	168.6	7.6	155.7	6.1	6.8	<0.001	173.0	7.5	158.8	7.4	5.6	<0.001
Weight (kg)	89.1	19.3	70.3	13.8	4.9	0.000	85.2	14.7	79.0	19.2	1.3	0.184	79.4	12.6	75.6	13.0	0.9	0.380
Waist circumference (cm)	104.3	13.5	94.5	11.8	3.5	0.001	100.6	10.0	95.3	15.9	1.5	0.131	94.3	11.7	93.8	11.5	0.1	0.892
Mid upper arm circumference (cm)	29.7	3.2	28.3	3.8	1.9	0.056	29.5	2.8	31.7	4.4	−2.2	0.029	29.7	3.3	30.8	3.8	−0.9	0.369
Hip circumference (cm)	107.2	13.2	105.1	12.1	0.7	0.464	102.4	8.9	108.8	14.9	−1.9	0.057	100.6	7.4	108.6	7.2	−3.2	0.002
Triceps skinfold thickness (mm)	9.5	3.9	16.5	6.0	−6.6	<0.001	8.6	2.3	20.7	6.5	−9.7	<0.001	8.9	3.6	18.4	8.4	−4.7	<0.001
BMI (kg/m^2)	31.2	6.7	29.5	5.4	1.2	0.224	29.8	4.3	32.6	7.8	−1.6	0.107	26.5	3.9	29.9	4.3	−2.6	0.014
WHR	0.97	0.1	0.90	0.1	4.4	<0.001	0.98	0.1	0.87	0.1	6.2	<0.001	0.94	0.1	0.86	0.1	2.7	0.009
%F	24.8	6.0	32.6	5.8	−6.2	<0.001	24.6	3.9	35.1	5.9	−7.9	<0.001	24.0	5.8	32.1	7.9	−3.8	<0.001
Fat mass (kg)	22.4	7.9	23.3	7.2	−0.6	0.578	21.2	5.5	28.4	10.8	−3.2	0.002	19.3	6.2	24.9	9.4	−2.3	0.027
Fat free mass (kg)	66.7	13.9	47.0	8.4	7.4	<0.001	64.0	10.3	50.6	9.4	5.0	<0.001	60.1	9.0	50.8	7.1	3.2	0.002
Total upper arm area (cm^2)	71.1	15.4	64.9	17.5	1.8	0.076	69.7	13.4	81.4	22.9	−2.3	0.023	71.0	15.3	76.3	18.8	−1.0	0.345
Upper arm muscle area (cm^2)	57.5	12.0	43.2	10.8	5.8	<0.001	57.6	11.2	51.1	12.9	2.0	0.052	58.4	12.9	50.1	10.2	2.0	0.051
Upper arm fat area (cm^2)	13.6	6.3	21.7	9.8	−5.0	<0.001	12.1	3.6	30.2	12.2	−7.7	<0.001	12.7	5.4	26.2	13.5	−4.9	<0.001
Arm fat index (AFI)	18.7	6.6	32.6	8.0	−9.1	<0.001	17.3	4.1	36.2	7.8	−11.4	<0.001	17.6	6.5	33.0	11.1	−5.7	<0.001
Blood glucose (mg/dl)	150.3	59.6	162.8	58.8	1.2	0.218	186.0	101.7	160.2	67.4	−0.7	0.459	140.1	48.6	162.3	43.5	1.5	0.129
Total cholesterol (mg/dl)	165.8	38.7	182.6	45.2	−1.9	0.060	163.2	43.5	184.4	41.1	−1.8	0.071	166.3	35.6	167.1	41.6	−0.1	0.949
HDL cholesterol (mg/dl)	45.3	17.7	56.0	16.4	−3.3	0.002	41.6	11.7	52.5	13.0	−3.0	0.004	50.8	14.8	50.4	13.5	0.0	0.975
LDL cholesterol (mg/dl)	90.0	36.7	102.3	41.7	−1.4	0.172	86.5	29.0	99.8	33.0	−1.4	0.164	94.6	33.9	100.8	43.4	−0.2	0.844
Triglyceride (mg/dl)	163.5	90.1	126.8	57.2	1.7	0.093	165.4	86.3	137.8	69.8	1.2	0.232	106.3	45.8	113.6	53.3	−0.4	0.714
HbA1c (mmol/mol)	63.1	17.0	67.1	20.6	−1.0	0.342	67.1	19.7	62.1	16.2	1.0	0.346	62.0	17.9	64.7	13.6	−0.7	0.488

Table 4 Comparison of sociodemographic and lifestyle variables among sexes and groups within each sex in subjects with HbA1c higher (H) and lower (L) than 7%

	Italian males		Italian females		Albanian males		Albanian females		African males		African females	
	U	L	U	L	U	L	U	L	U	L	U	L
HbA1c	75.0	25.0	71.0	29.0	73.3	26.7	80.0	20.0	65.6	34.4	75.0	25.0
Educational level												
None	–	–	–	–	–	–	–	–	14.3	36.4	22.2	33.3
Primary school	19.6	29.4	45.5	55.6	9.1	25.0	5.0	20.0	28.6	27.3	11.1	66.7
Junior high school	43.1	41.2	36.4	22.2	50.0	37.5	30.0	–	38.1	36.4	33.3	–
High school	31.4	29.4	13.6	11.1	40.9	37.5	50.0	60.0	9.5	–	22.2	–
University	5.9	0.0	4.5	11.1	–	–	15.0	20.0	9.5	–	11.1	–
Smoker												
No	27.5	23.5	54.5	66.7	27.3	37.5	90.0	100.0	66.7	72.7	88.9	100.0
Yes	25.5	17.6	22.7	11.1	18.2	12.5	–	–	9.5	27.3	11.1	–
Ex	47.1	58.8	22.7	22.2	54.5	50.0	10.0	–	23.8	–	–	–
Alcohol												
Yes	82.4[a]	58.8	31.8	33.3	63.6	37.5	25.0	–	4.8	9.1	–	–
Sport												
No	78.4	88.2	95.5	88.9	90.9	100.0	95.0	80.0	85.7	90.9	88.9	100.0
High-intensity activities												
No	92.2	88.2	100.0	100.0	100.0	100.0	100.0	100.0	81.0	72.7	100.0	100.0
Moderate-intensity activities												
No	33.3	47.1	59.1	33.3	27.3	50.0	50.0	80.0	42.9	36.4	88.9*	33.3

*Significant difference ($p < 0.05$) between U and L comparisons performed using the χ^2 test

the African males had been living in Italy for a significant longer time than Albanians (23.8 years vs 15.3 years), while the years of residence in Italy did not differ between females (14.4 in Africans vs 13.5 in Albanians). Agyemang et al. [53] suggested that among ethnic minority groups living in industrialized societies the risk of diabetes could be further increased in those countries with more diabetogenic environments in terms of diet, urban design and transport, and health policies. Rimini, where the study was carried out, is a small city (number of inhabitants = 149.413) and the municipality's attention to immigrants is high.

Another aspect considered in the present study was the assessment of the quality of glycemic control. Marzona et al. [52], reporting the results of studies conducted on administrative databases of some Italian regions, indicated that management of diabetes was scanty among immigrants. Immigrants encounter sociocultural barriers (language, communication, sociocultural factors, and "news-ness") in accessing healthcare. Classic studies conducted on subjects with type 1 and type 2 diabetes have convincingly demonstrated that intensive glycemic control (HbA1c ~7.0%) reduces chronic microvascular complications and, in the long-term, can also reduce the occurrence of nonfatal acute myocardial infarction [33, 34]. In the present study, no significant differences in glycemic control (subjects with HbA1c > 7.0%) among groups and sexes were detected. The percentage varied in males from 65.6% in Africans to 75% in Italians and in females from 71% in Italians to 80% in Albanians. In all groups, the proportion was higher than the values reported for other immigrant groups in Europe [30, 54, 55]. Regarding the difference between U and L within each group and sex, the level of education, weight status, cigarette smoking, alcohol consumption, sport practice, and intensity of physical activity were quite similar. The only differences were detected in Italian males, where H showed higher prevalence of smokers and WHR than L, indicating once more the greater imbalance in Italian sample. There were significantly higher values of glucose in U than in L in all groups, except in African females. The same condition appeared for triglycerides in males.

The Italian healthcare system allows all immigrants entering Italy with legal permission to have access to healthcare [52]. It is possible that the conditions detected in the present study are due to the fact that long-term immigrants might feel confident about their access to care, having received adequate information concerning the health system in this country.

The strength of the present study is that it is one of the first to analyze the anthropometric, clinical, and lifestyle characteristics of immigrants with T2DM in Italy, a subject rarely investigated thus far. In addition, the anthropometric characteristics were directly surveyed on patients by an

Table 5 Comparison of anthropometric and hematological variables among sexes and groups within each sex in subjects with HbA1c higher (H) and lower (L) than 7%

	Italian males			Italian females			Albanian males			Albanian females			African males			African females		
	U	L		U	L		U	L		U	L		U	L		U	L	
	Mean	Mean	*P* value	Mean	Mean	*P* value	Mean	Mean	*P* value	Mean	Mean	*P* value	Mean	Mean	*P* value	Mean	Mean	*P* value
Age (years)	60.4	62.6	0.590	68.5	68.4	0.992	65.1	58.9	0.070	45.9	57.1	0.080	52.9	52.2	0.803	44.1	53.3	0.474
Years in Italy							15.4	15.2	0.964	10.0	14.4	0.187	25.5	23.7	0.557	10.0	15.9	0.451
Weight (kg)	89.1	89.1	0.998	68.2	72.1	0.458	83.5	89.8	0.303	81.2	70.4	0.271	78.7	80.9	0.653	75.1	77.2	0.825
Mid upper arm circumference (cm)	29.6	30.2	0.470	28.0	28.6	0.702	29.4	29.6	0.848	32.2	29.6	0.243	29.4	30.4	0.425	30.7	31.0	0.902
Waist circumference (cm)	104.9	102.4	0.515	93.0	94.9	0.660	99.6	103.6	0.335	96.9	88.8	0.320	94.7	93.9	0.853	92.3	98.4	0.456
Hip circumference (cm)	105.9	111.1	0.157	102.1	108.7	0.106	100.9	106.5	0.135	110.4	102.2	0.280	100.5	100.6	0.964	107.7	111.0	0.527
Triceps skinfold thickness (mm)	9.1	10.5	0.213	16.5	16.6	0.684	8.6	8.3	0.765	20.8	20.5	0.973	8.6	9.2	0.612	19.4	15.3	0.717
BMI (kg/m^2)	31.0	31.9	0.635	28.3	30.8	0.181	29.6	30.6	0.552	33.5	28.7	0.225	26.5	26.7	0.919	29.5	31.3	0.550
WHR	1.0	0.9	0.003	0.91	0.87	0.243	0.99	0.98	0.602	0.88	0.87	0.877	0.94	0.93	0.672	0.86	0.88	0.612
%F	24.6	25.4	0.619	33.0	31.9	0.654	24.7	24.3	0.845	35.6	33.0	0.396	23.5	24.8	0.540	33.0	29.7	0.553
Fat mass (kg)	22.1	23.3	0.574	22.7	23.8	0.695	20.8	22.2	0.560	29.7	23.5	0.259	18.7	20.4	0.460	25.5	22.8	0.687
Fat free mass (kg)	67.1	65.8	0.750	45.5	48.3	0.370	62.7	67.7	0.249	51.5	46.9	0.342	60.0	60.4	0.905	49.6	54.3	0.334
Total upper arm area (cm^2)	70.2	73.7	0.428	63.4	66.3	0.673	69.5	70.4	0.864	84.1	70.3	0.234	69.6	74.8	0.378	76.2	76.5	0.984
Upper arm muscle area (cm^2)	57.2	58.3	0.747	42.0	43.9	0.654	57.2	58.6	0.781	53.2	42.9	0.111	57.5	61.2	0.447	48.6	54.6	0.405
Upper arm fat area (cm^2)	13.0	15.4	0.184	21.4	22.4	0.790	12.2	11.9	0.821	30.9	27.4	0.580	12.1	13.6	0.484	27.6	21.9	0.552
Blood glucose (mg/dl)	163.2	111.5	0.002	179.8	101.8	0.000	211.8	114.9	0.018	175.6	98.4	0.009	156.9	106.2	0.092	173.3	129.0	0.112
Total cholesterol (mg/dl)	166.5	163.6	0.791	178.1	193.6	0.396	168.7	148.0	0.257	182.1	193.4	0.594	165.3	164.9	0.975	166.8	168.0	0.967
HDL cholesterol (mg/dl)	42.9	52.4	0.037	56.7	54.2	0.644	40.6	44.4	0.290	53.1	50.0	0.782	50.0	53.0	0.635	53.0	42.7	0.285
LDL cholesterol (mg/dl)	91.1	86.7	0.901	98.5	111.6	0.540	87.4	84.3	0.977	95.6	115.8	0.205	92.4	95.3	0.956	94.9	118.7	0.613
Triglyceride (mg/dl)	178.5	118.6	0.025	122.0	138.7	0.523	186.2	108.3	0.041	140.9	126.6	0.709	116.9	83.9	0.035	110.1	124.0	0.510

expert technician, thus avoiding underestimation of the prevalence of overweight or misreports inherent in self-reported data.

One of the main limitations of this study is that the sample was drawn from patients rather than being based on the general population, and thus no data could be gathered about the prevalence of the disease. In addition, although the sample size was not very large, it must be taken into account that all the immigrants who had turned to the hospital were measured.

Conclusions

This study of immigration and T2DM in Italy showed that there were no differences in the clinical characteristics between immigrant diabetics and native Italian diabetics and that Italians generally presented worse lifestyle habits. The percentage of subjects with poor metabolic control of diabetes was not low, but it was generally comparable between immigrants and natives. Since the number of migrants is increasing at present, mainly in the southern part of Europe, there is a clear necessity to acquire knowledge of diabetes in immigrants through better data collection, especially in view of the scarcity of epidemiological studies evaluating the importance of this problem in EU countries.

Author contributions All authors contributed to the preparation of the paper. S.T., F.C., and P.M. had the original idea for the trial and carried out the design with E.G.R. S.T. carried out the analysis reported in this paper, under the supervision of F.C. and E.G.R., and also prepared the initial draft of the paper. All authors critically reviewed the paper and approved the final version submitted for publication.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The Project was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Romagna Area Regional Health System. All participants gave written informed consent after a detailed description of the study procedures.

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